The Bronchial Tree and Lobular Division of the Dog Lung

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ABSTRACT. The right lung of the dog consists of the cranial, middle, caudal and accessory lobes. The left lung consists of the bilobed middle and caudal lobes. These lobes are separated by interlobular fissures on either side. The dog lung has four bronchial systems, dorsal, lateral, ventral and medial, on either side. The right cranial lobe is formed by the first bronchial of the dorsal bronchial system. The right middle lobe is formed by the first bronchial of the lateral bronchial system, and the right accessory lobe is formed by the first bronchial of the ventral bronchial system. The remaining bronchial systems of the dorsal, lateral and ventral bronchial systems and all the bronchioles of the medial bronchial system constitute the right caudal lobe. In the left lung, the left middle lobe is formed by the first bronchial of the lateral bronchial system. The remaining bronchial systems of the lateral bronchial system and all the bronchioles of the dorsal, ventral and medial bronchial systems constitute the left caudal lobe. These findings are compared with those in other domestic animals and man.- KEY WORDS: bronchial tree, canine, lobular division of lung.


Aebi [1] examined the lungs of many mammals including man, and classified the bronchioles into the dorsal and ventral bronchial systems. Furthermore, he classified the bronchioles into epirterial and hypoarterial bronchioles according to the course of the pulmonary artery, and considered the left epirterial bronchopyle, i.e., the left upper lobe bronchopyle, to be lacking in the human lung. Huntington [3] also examined many mammalian lungs and considered the left upper lobe bronchopyle and the left middle lobe bronchopyle to have a short common trunk originating from the left bronchus. On the other hand, Jackson and Huber [4] divided the human lung into ten pulmonary segments on either side for the convenience of surgery. They considered the left upper lobe to correspond to the right upper and middle lobes. Externally, however, the right lung consists of the upper, middle and lower lobes, and the left lung consists of the upper and lower lobes, the middle lobe being absent.

In veterinary anatomy, the lobular division of Ellenberger and Baum [2] was accepted for a long time. This discriminated the apical, cardiac, diaphragmatic and intermediate lobes in the right lung, and the apical, cardiac and diaphragmatic lobes in the left lung, except for the horse lung. However, Seiferle [8] pointed out that the left cardiac lobe by Ellenberger and Baum [2] is part of the apical lobe. At present, this is widely accepted in veterinary anatomy. In this way, the interpretations of the left lung have differed among authors.

Therefore, the present author examined many mammalian lungs to establish the fundamental structure of the bronchial ramifications. It was concluded that the dorsal, lateral, ventral and medial bronchial systems arise from the dorsal, lateral, ventral and medial sides of both bronchi, respectively. Furthermore, two pairs of bronchioles arise from the lateral sides of the trachea. The cranial lobe bronchial, are the first bronchiole of the dorsal bronchial system (cranial lobe bronchiole I) and the two bronchioles arising from the trachea (cranial lobe bronchioles II and III). In this way, three cranial lobe bronchioles can be enumerated. However, in general, the cranial lobe can be formed by any one of them. The middle lobe bronchiole is the first bronchiole of the lateral bronchial system. The accessory lobe bronchiole is the first bronchiole of the ventral bronchial system. The remaining bronchioles of the four bronchial systems constitute the caudal lobe [5, 6].

In an earlier report, the present author described the main portion of the bronchial tree of domestic animals [6]. However, from a clinical standpoint, the peripheral portion of the bronchial tree is also necessary. Therefore, the present author has already reported detail of the whole bronchial tree of the horse [7]. In this paper, the author deals with the whole bronchial tree of the dog, including the peripheral portion.

MATERIALS AND METHODS

Lungs from thirty-three apparently healthy mongrel dogs were used. All of the dogs had been euthanized by an injection of sodium pentobarbital. Thirteen of them were injected with variously colored cellulosic solutions into the bronchial tree and blood vessels through the trachea and heart with the aid of a metal syringe. Nine other specimens were injected into the bronchial tree and pulmonary artery, and eleven into the bronchial tree only. After completion of the injections, these lungs were placed in water until the cellulosic had completely coagulated. Then, the soft tissues were treated with hydrochloric acid (HCl). The cast models were obtained after washing in running water (Fig. 1).

In this report, the author mainly describes the dominant type of bronchial ramification in the dog, on the basis of the above proposed system of nomenclature [5, 6], from the viewpoint of comparative anatomy.
RESULTS

**Bronchial ramification and lobular division (Figs. 1-4):**
The trachea divides into the right and left bronchi, which extend in a caudal direction in the right and left lungs. Both bronchi give off many bronchioles stereotaxically. These bronchioles can be classified into the dorsal (D), lateral (L), ventral (V) and medial (M) bronchiole systems.

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**Fig. 1:** Ventral aspect. Celluloid cast model of the bronchial tree of the dog lung.

**Fig. 2:** Ventral aspect of the bronchial tree of the dog lung.

**Fig. 3:** Lateral aspect of the right lung.

**Fig. 4:** Lateral aspect of the left lung.

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D - dorsal bronchiole system  
L - lateral bronchiole system  
V - ventral bronchiole system  
M - medial bronchiole system  
D₁ - cranial lobe bronchiole (cranial lobe bronchiole 1)  
L₁ - middle lobe bronchiole  
V₁ - accessory lobe bronchiole  
The remaining bronchioles of the four bronchiole systems constitute the caudal lobe.  
R.P.A. - right pulmonary artery  
L.P.A. - left pulmonary artery
on either side. Furthermore, these bronchioles give off many side branches (Figs. 1–4).

The right cranial lobe bronchiole of the dog corresponds to the first bronchiole (D1) of the dorsal bronchiole system, i.e. the cranial lobe bronchiole I, and the cranial lobe bronchioles II and III are absent. The right cranial lobe bronchiole I arises from the dorsolateral side of the right bronchus and divides into two branches, cranial (a) and caudal (b). The cranial branch (a) is more developed than the caudal branch (b), and gives off side branches in both dorsal and ventral directions, among which the first side branch arising from the dorsal side of the main trunk of the cranial branch (a) is well developed (Figs. 2, 3). The caudal branch (b) divides into two branches, dorsal and ventral. This bronchiole constitutes the right cranial lobe. The right middle lobe bronchiole arises from the ventrolateral side of the right bronchus. This bronchiole corresponds to the first bronchiole (L1) of the lateral bronchiole system and extends in a ventrolateral direction, giving off side branches on both the cranial and caudal sides. The first side branch arising from the caudalateral side of the main trunk is often well developed compared with the other side branches. This bronchiole forms the right middle lobe. The right accessory lobe bronchiole is the first bronchiole (V1) of the ventral bronchiole system and arises from the ventromedial side of the right bronchus, dividing into two branches, lateral and medial (Fig. 2). This bronchiole constitutes the right accessory lobe. The remaining bronchioles of the dorsal, lateral and ventral bronchiole systems and all the bronchioles of the medial bronchiole system constitute the right caudal lobe. In the right caudal lobe, the lateral bronchiole system is the most developed and has the second (L2) to fifth (L5) bronchioles, continuously. The branches arising from the cranial side of the second bronchioles (L2) of the lateral bronchiole system are well developed. The third bronchiole (L3) divides into two branches in its distal portion. The fourth (L4) and fifth (L5) bronchioles do not divide, and the former is sometimes small or lacking. The dorsal bronchiole system has the second (D2) to seventh (D7) bronchioles. The ventral bronchiole system has the second (V2), third (V3) and fifth (V5) bronchioles. The medial bronchiole system has the third (M3), fifth (M5) and sixth (M6) bronchioles (Fig. 2). Accordingly, the left lung consists of the bilobed middle and caudal lobes, both of which are separated by an interlobular fissure (Fig. 4).

**DISCUSSION**

The anatomical terms used in this report, i.e. the cranial lobe, middle lobe, caudal lobe and right accessory lobe, correspond to the upper lobe, middle lobe, lower lobe and right medial basal segment (S2) of the human lung, respectively. However, in the human left lung, the upper lobe and medial basal segment (S2) are absent from the viewpoint of comparative anatomy [5, 6]. The term bronchiole corresponds to a lobar bronchus arising from the right and left bronchi, or a segmental bronchus arising from the caudal lobe bronchi in veterinary anatomy.

There is a numerical variation as to bronchioles arising from the right and left bronchi, especially in the ventral (V) and medial (M) bronchiole systems. Furthermore, the bronchiole ramifications and their extensions in the lung are also variable. However, if we know the fundamental type of bronchiial ramifications, then the bronchioles can be easily identified. Therefore, in this report, the author described mainly the dominant type of bronchial ramifications.

The left middle lobe bronchiole, as designated by the present author, corresponds to the common trunk of the bronchioles (bronchi) forming the left apical and cardiac lobes of Ellenberger and Baum [2] in the cow, pig or dog. Furthermore, each of them corresponds to the left apical lobe bronchiole (bronchus) of Seiferle [8]. At present, in veterinary anatomy, these bronchioles are called the left
cranial lobe bronchiole (bronchus).

However, the right cranial lobe bronchiole of the dog is the first bronchiole (D₁) of the dorsal bronchiole system and arises from the dorsolateral side of the right bronchus. It is an epiarterial bronchiole because it is located on the cranial side of the right pulmonary artery. The right middle lobe bronchiole is the first bronchiole (L₁) of the lateral bronchiole system and arises from the ventrolateral side of the right bronchus. It is one of the hypoarterial bronchioles because it is located on the caudal side of the right pulmonary artery. In this way, the cranial lobe bronchiole and the middle lobe bronchiole are completely different from each other in their bronchiole systems, the origin of their bronchioles and their relationship to the pulmonary artery.

The left middle lobe bronchiole, as designated by the present author, arises from the ventrolateral side of the left bronchus and corresponds to the first bronchiole (L₁) of the lateral bronchiole system, although the origin of this bronchiole is more cranial than that of the right middle lobe bronchiole. Furthermore, it is a hypoarterial bronchiole. Therefore, from these features, this bronchiole does not correspond to the right cranial lobe bronchiole, but to the right middle lobe bronchiole. Therefore, the left cranial lobe bronchiole of the dog, as currently accepted in veterinary anatomy, should be called the left middle lobe bronchiole (bronchus). Furthermore, this bronchiole also corresponds to the left cranial lobe bronchioles of the cow and pig, or to the left upper (cranial) lobe bronchiole (bronchus) of man. Therefore, the left cranial (upper) lobe bronchiole of these animals and man also should be called the left middle lobe bronchiole from the viewpoint of the comparative anatomy [5, 6].

In order to identify the lung lobes, it is important to take into consideration not only their external features but also their bronchial ramifications and relationship to the pulmonary artery.

REFERENCES